

WHAT IS CLAIMED IS:

1. An optical system for directing light from a light source to a predetermined plane, comprising:

5 at least one optical element disposed in an inside space of said optical system;

a measuring mechanism for measuring a surface shape of the at least one optical element; and

10 a temperature controller for controlling a temperature of the at least one optical element on the basis of the measurement made by said measuring mechanism.

15 2. An optical system according to Claim 1, wherein said measuring mechanism performs position measurement to a surface of the at least one optical element, at plural locations on that surface.

20

3. An exposure apparatus including an optical system as recited in Claim 1.

25 4. A device manufacturing method, comprising the steps of:

exposing an object to be exposed, by use of an exposure apparatus as recited in Claim

3; and

developing the exposed object.

5. An optical system for directing light
5 from a light source to a predetermined plane,
comprising:

an optical element;

position measurement to a surface of the optical
10 element, at plural measurement points on that
surface;

a first temperature controlling
mechanism for controlling temperature of a first
control region of the optical element;

15 a second temperature controlling
mechanism for controlling temperature of a second
control region of the optical element; and

20 a temperature controller for
controlling said first and second temperature
controlling mechanisms on the basis of the
measurement made by said measuring mechanism.

6. An optical system according to Claim 5,
wherein the first control region is at a top or
25 front face side of the optical element while the
second control region is at a bottom or rear face
side of the optical element.

7. An optical system according to Claim 5,
wherein both of the first and second control
regions are at a bottom or rear face side of the
5 optical element.

8. An optical system according to Claim 5,
wherein both of the first and second control
regions are at a top or rear face side of the
10 optical element.

9. An optical system according to Claim 5,
wherein the surface of the optical element is one
of reflective surface, refractive surface and
15 diffractive surface.

10. An optical system according to Claim 5,
wherein said temperature controller controls said
first and second temperature controlling
20 mechanisms so that, through application of a
stress to the optical element, a result of
measurement made by said measuring mechanism is
held in a predetermined range.

25 11. An optical system according to Claim 5,
wherein said temperature controller controls said
first and second temperature controlling

mechanisms on the basis of the measurement made by said measuring mechanism, so that different temperatures are defined at the first and second control regions, respectively.

5

12. An optical system according to Claim 5,
wherein said measuring mechanism is operable to
measure a shape of the surface of the optical
element, with respect to two sections being
10 approximately perpendicular to each other.

13. An optical system according to Claim 12,
wherein the two approximately perpendicular
sections are approximately registered with a
15 lengthwise direction and a widthwise direction of
a predetermined region of the optical element
which region is to be illuminated with light.

14. An optical system according to Claim 13,
20 wherein said temperature controller performs
temperature control so as to reduce deformation of
the optical element with respect to the two
directions being approximately perpendicular to
each other, to be measured by said measuring
25 mechanism.

15. An optical system according to Claim 5,

wherein said temperature controller performs different temperature controls to the first and second control regions, respectively.

5 16. An optical system according to Claim 5,
wherein at least one of the plural measurement
points is inside a predetermined region of the
optical element which region is to be illuminated
with light.

10

17. An optical system according to Claim 5,
wherein at least one of the plural measurement
points is outside a predetermined region of the
optical element which region is to be illuminated
15 with light.

18. An optical system according to Claim 5,
wherein the plural measurement points are inside a
predetermined region of the optical element which
20 region is to be illuminated with light.

19. An optical system according to Claim 5,
wherein the plural measurement points are outside
a predetermined region of the optical element
25 which region is to be illuminated with light.

20. An optical system according to Claim 5,

wherein one of the plural measurement points is approximately at a center of a predetermined region of the optical element which region is to be illuminated with light.

5

21. An optical system according to Claim 5, wherein said measuring mechanism performs position measurement to the surface of the optical element, at three or more measurement points on that surface.

10

22. An optical system according to Claim 5, wherein the optical element has a linear expansion coefficient of not less than 0 ppb and not greater than 15 ppb.

15

23. An optical system according to Claim 5, wherein the optical element has a linear expansion coefficient of not less than 0 ppb and not greater than 10 ppb.

20

24. An exposure apparatus including an optical system as recited in Claim 5.

25

25. A device manufacturing method, comprising the steps of:
exposing an object to be exposed, by

use of an exposure apparatus as recited in Claim
24; and

developing the exposed object.